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A Research Model to Test the Understandability of Hybrid Process Models Using DCR Graphs

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Abstract. While the understandability of process models has been extensively investigated for different process modeling notations, it has not been yet broadened to cover hybrid models. This paper proposes a new research model to investigate the understandability of hybrid model representations using a variety of psycho-physiological measurements including eye tracking and galvanic skin response (GSR) together with verbal data analysis. The aim of this research is to ensure a smooth integration of hybrid modelling technologies in public administrations by investigating the way end-users (i.e., case workers) rely on the different parts of the hybrid process model representation in DCR Graphs, i.e., the graph, the textual annotations describing the law, and the simulation tools to interpret the process model.

1 Introduction

The Ecoknow[3] project aims at developing solutions for the effective digitalization of knowledge work processes. Using hybrid modelling technologies, Ecoknow proposes a new Advanced Case Management (ACM) system that combines both flexibility and compliance with the law. Since this technology empowers end users (i.e, case workers) and place them in the center of the decision making process, it is crucial to ensure its ease of use. By investigating the way end users interact with the different parts of the hybrid process model representation in DCR graphs (i.e., the graph, the textual annotations describing the law, and the simulation tools; cf. Figure 1), the understandability and effectiveness of this approach can be evaluated. This paper proposes a new research model to investigate the understandability of hybrid models using a variety of physio-psychological measurements derived from questionnaires, user interactions, eye tracking data, verbal data, and GSR signal. The outcome can then be used to further improve the platform and contribute to higher user satisfaction and compliance with the law. Section 2 briefly presents the related work, Section 3 introduces our research method, and finally Section 4 concludes the paper.

[3] See `https://ecoknow.org`

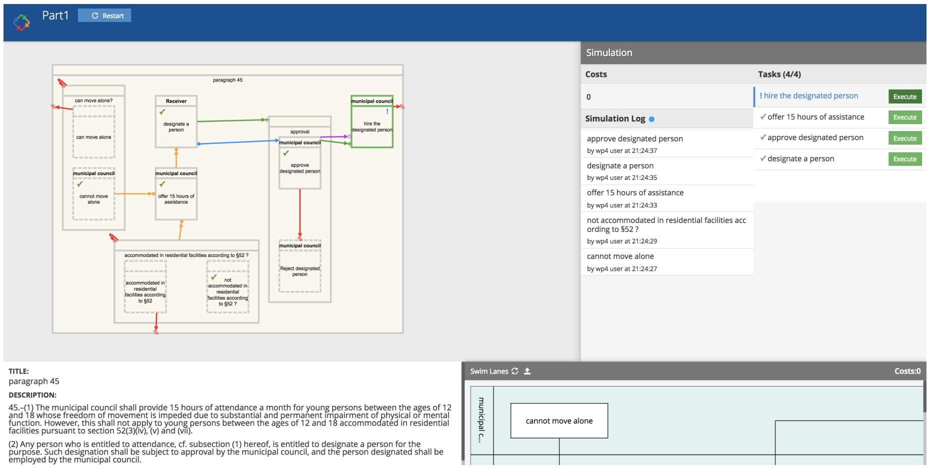

Fig. 1: A hybrid representation of DCR graphs. The hybrid representation includes the DCR graph, the textual annotations, and the simulation tools.

2 Related work

Hybrid model representations are usually used in the following contexts: *(a)* Combination of two modeling notations. In this context, several hybrid notations have been proposed in [2, 3, 7] and [11] to combine imperative and declarative notations. *(b)* Combination of model notation with textual annotation, namely, Pinggera et al. in [6] proposed the Literate Process Modeling technique (LiProMo) that aims at improving the communication during the process of process modeling by inter-waving textual descriptions with process models. Also, Wang et al. in [10] suggested a hybrid representation that combines a graphical representation of the process model and a textual annotation prescribing the underlying linked rules. *(c)* Support of model notation with test cases. This approach has been proposed and evaluated by Zugal et al. in [14–16]. The approach uses Test Driven Modelling (TDM) to improve the understandability of declarative models.

The hybrid representation introduced by the DCR portal combines the model notation, with the textual annotation, and offers the support of the simulation tool. Thus, its context is similar to the approaches proposed in *(a)* and *(b)*.

3 Research Method

This study investigates the factors affecting the understandability of hybrid model representations using multi-modal data collection. In particular, an eye tracking study supported by questionnaires, GSR signal recording, users interactions, and retrospective think-aloud [5, p. 104-108] is conducted to provide insights from different angles.

Afterwards, a quantitative analysis is performed on the eye tracking data, the questionnaire data, the user interactions, and the GSR signal. While the verbal data obtained from the retrospective think-aloud is transcribed and processed based on grounded theory [8], such that the recurrent aspects are identified and grouped into categories that are further analyzed and refined at the analysis phase. The same approach has been successfully used in a similar empirical research study held by Haisjack et al. in [4], where the authors have investigated the understanding of declarative process models.

The following sections describe the key aspects considered by the planning phase of our exploratory study. Section 3.1 defines the main research problem, Section 3.2 describes the experiment subjects, Section 3.3 presents the experiment objects, and Section 3.4 explains the measures.

3.1 Research Problem

The aim of this study is to understand how subjects with different levels of expertise in DCR will use the different artifacts provided by the DCR portal (graph, textual annotations describing the law, simulation tools) to answer a set of model related questions. The research problem is formulated into the following research questions:

- **RQ1:** How is the subjects' attention distributed over the different artifacts provided by the hybrid representation during a comprehension session?
- **RQ2:** In what circumstances do the subjects rely more on one artifact rather than another to answer the model questions?
- **RQ3:** To what extend does the hybrid representation contribute to answer the model questions correctly?
- **RQ4:** How does the subjects process and merge the information coming from the graph, the textual annotations describing the law, and the simulation tools?

The research questions presented in this section aim at investigating the aspects we suspect to be relevant to our exploratory study. Namely, Question RQ1 investigates whether the subjects will be using the artifacts provided by the hybrid representation accordingly. In other words, we expect that depending on the experiment question, one or many artifacts should be used to answer that question. The total time spent looking at/interacting with each artifact can provide indications about its usability (cf. Section 3.4 for more details). Question RQ2 identifies the circumstances/conditions when the subjects rely more on one artifacts than another. These circumstances are expected to vary depending on the model questions type (i.e., asking about a specific control-flow execution vs. asking about a general behaviour in the model), and probably the complexity of the targeted part of the DCR graph (i.e., the use of relations such as condition, response, include, exclude, milestone). Question RQ3 examines the extent to which the use of different artifacts contributes in answering the experiment questions correctly. In this context, it is expected that the subjects who rely on specific artifacts are most likely to provide correct answers. Finally, Question RQ4 addresses the cognitive aspect of using a hybrid representation. By exploring the subjects' gaze data and the interaction logs we expect to identify the common reading patterns and to analyze the information merging strategies used by the subjects.

3.2 Subjects

The subjects who participated in this experiment have different backgrounds and different levels of expertise in using DCR graphs. The initial sample comprises subjects employed at the Syddjurs municipality[4] (i.e., case workers), and students/employees from two danish universities[5]. The subjects from Syddjurs municipality have limited experience with DCR graphs while the subjects from the universities are more advanced in using DCR graphs.

As a minimal knowledge about the hybrid representation offered by the DCR portal (cf. Figure 1) and the experiment procedure are required for all participants regardless of their level of expertise, all the subjects had a basic training prior to the experiment.

3.3 Objects

The DCR model used in this study originate from Section §45 of the "Consolidation Act on Social Services". The experiment was designed in both English and Danish. The law texts for both versions are available online[6]. In order to evaluate the understandability of the different artifacts of the hybrid representation, we have designed a set of questions that can be categorized as follows:

- Trace questions asking about a specific control-flow execution (trace). We expect that these questions will be more engaging to use the simulation tools in order to provide correct answers.
- Model-law questions asking about details that we assume to be easily recognized from the law text fragments shown at the description of the DCR graph activities.
- Model questions asking about details that can be inferred by looking closely at the DCR graph semantics.
- General Purpose questions asking to identify and describe specific subsections of the law text in the DCR graph. The aim is to engage the subjects in the process of model comprehension and assess their understandability of the DCR graph semantics.

[4] Danish Minicipality, See `https://www.syddjurs.dk`

[5] IT University of Copenhagen (ITU) and Technical University of Denmark (DTU)

[6] For English version see `http://english.sm.dk/media/14900/consolidation-act-on-social-services.pdf`, and for Danish version see `https://www.retsinformation.dk/Forms/R0710.aspx?id=197036`

In addition, we use extra questions to assess the cognitive load and the feelings of the subject at the end of each trial. The answers provided are validated against the data recorded by the eye tracker, the GSR device, and the user interactions.

3.4 Measures

To obtain an understanding of the understandability of hybrid models we use multi-modal data collection. More specifically, we rely on questionnaires, user interactions, eye tracking data, verbal data, and GSR signal. This section provides an overview about each of the measurements and highlights its domain of application.

The questionnaire data is used to measure the answering accuracy, perceived cognitive load [13], as well emotional responses (i.e., valence and arousal using MANIKIN [1]). The model questions are crafted as dichotomous questions (i.e., true/false), while the perceived cognitive load and emotional responses are measured using a 9-point Likert scale.

The gaze data recorded during the experiment is also of high importance. The two primary gaze events inferred from the gaze data are *fixations* and *saccades*. A fixation refers to the period of time where the eye remains still [5, p. 21]. For example, when reading a sentence, the period of time the eye stops at a word is considered as a fixation. A saccade refers to the rapid movement of the eye from one fixation to another [5, p. 23]. Fixations and saccades can be detected using different oculomotor events estimation algorithms [5, p. 147-186]. The availability of these two events allow to perform several type of eye tracking analysis. For instance, one can compare the fixation duration and the fixation count between different areas of interest. Indeed, it it is possible to split the view provided by the user interface into areas, such that each area is seen as a distinct area of interest (AOI) (i.e., graph, law text, simulation tools). Given a drawing of the AOIs as shown in Figure 2 one can compare the fixation duration and the fixation count between the different artifacts. Furthermore, using the saccades one can build a transition matrix showing all the transitions between the different area of interests [5, p. 193-197]. Fixations and saccades can be also used to infer other measures such as *Attention Maps*, and *Scanpaths*. Attention maps provide a good overview over the data. they use different colors to emphasis on the number of fixations the subjects have made on different parts of the stimulus [5, p. 231-251]. While *Scanpaths* allow to perceive the viewing patterns of subjects by displaying on the stimulus a route showing the sequence of fixations and saccades recorded during a certain timespan [5, p. 253].

The interaction logs, in turn, allow mapping the interaction events (i.e., mouse hovering and clicks over model artifacts and use of simulation) with the gaze events for a better analysis of the subjects' behavior. In addition, they can be be transformed to event logs and analyzed using state-of-art process mining techniques [9].

This exploratory study takes also advantage from additional channels such as the verbal data extracted from the retrospective think-aloud session held by

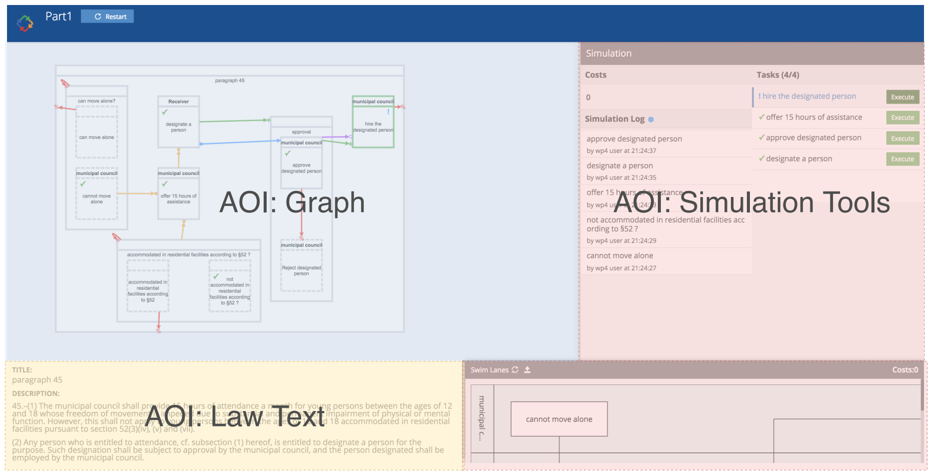

Fig. 2: Example of AOIs depicted on the hybrid version of DCR portal. The example contains 3 areas of interest: Graph, Law Text, Simulation Tools. By projecting these area of interests on a video recording the user interactions and the gaze data during a comprehension task, it becomes possible to map each gaze event (i.e., fixation), or user interaction event to its corresponding area of interest.

the end of each experiment session and the galvanic skin response data provided by the GSR device. The variations in the GSR signal provide insights about arousal and valance which in turn allow to get insights about the cognitive load and the emotional reactions of the subject during the experiment [5, p. 231-251]. This part is tightly related to a previous work done by Westerman et al. in [12], where the authors analyzed usability tasks based on GSR data.

4 Conclusion and Future Work

This paper summarizes the research model, we have developed to investigate the understandability of hybrid models. The various data channels enable a multi-model data collection, and open up opportunities for several types of data analysis.

As future work, we are planning to analyze the experiment data. Our main research problem is about understanding the way subjects with different levels of expertise will use the hybrid representation proposed by DCR graphs. By the end of this study, we aim at providing convincing answers to the research questions presented in Section 3.1.

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